

## Alternative Solvents Through Green Chemistry Project

Does Not Apply

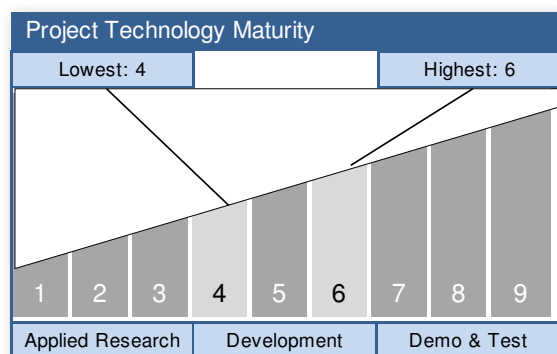
Human Exploration And Operations Mission Directorate ( HEOMD )

National Aeronautics and  
Space Administration

## ABSTRACT

Components in the aerospace industry must perform with accuracy and precision under extreme conditions, and surface contamination can be detrimental to the desired performance, especially in cases when the components come into contact with strong oxidizers such as liquid oxygen. Therefore, precision cleaning is an important part of a component's preparation prior to utilization in aerospace applications. Current cleaning technologies employ a variety of cleaning agents, many of which are halogenated solvents that are either toxic or cause environmental damage. ...***Read more on the last page.***

Supercritical Carbon Dioxide System



Technology Area: Ground & Launch Systems Processing TA13  
(Primary)

## ANTICIPATED BENEFITS

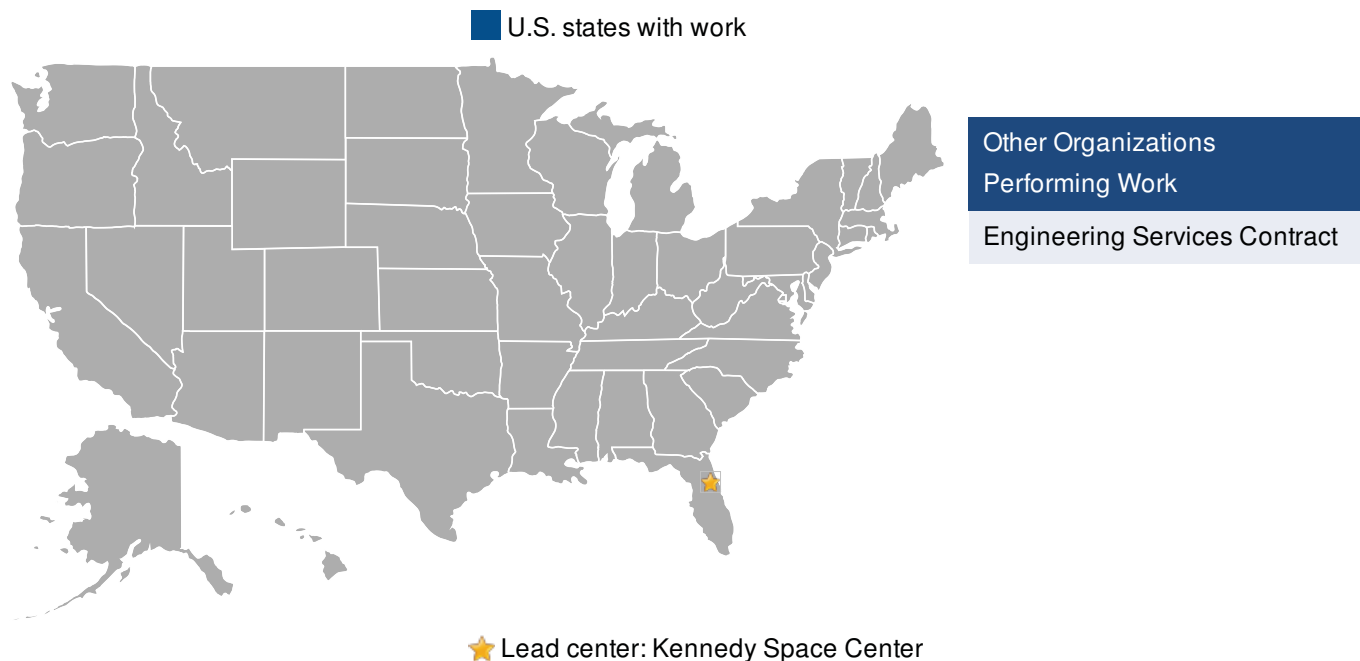
**To NASA funded missions:**

This project benefits NASA missions by eliminating the potential costs of cleaning up environmental contamination, and by eliminating the technical risk of having a solvent become unavailable.

**To NASA unfunded & planned missions:**

Future missions will benefit by not having to identify new cleaning solvents or methods when existing solvents become unavailable due to environmental ...

Read more on the last page.



## DETAILED DESCRIPTION

The purpose of this project is to develop state-of-the-art, green precision cleaning technologies for NASA's 21st Century Launch Complex thus eliminating long-term environmental costs to the Program. Precision cleaning is of critical importance in the aerospace industry. Failure to clean to specified levels may result in problems ranging from impaired performance to catastrophic failure. Of particular concern is the cleaning of systems containing strong oxidizers such as liquid oxygen (LOX) or hypergolic fuels. Currently, precision cleaning at Kennedy Space Center is performed using dual-solvent process in which the first solvent, Vertrel MCA, is used to clean the component and a second solvent, HFE-7100, is used as a final rinse and analytical test fluid. Highly fluorinated compounds such as those used in Vertrel MCA are extremely persistent in the environment and are potent greenhouse gases. Continued use of this or similar solvents will lead to high remediation costs that must be carried by the Program for years to come.

Historically, precision cleaning has used chlorofluorocarbons (CFCs), such as Freon, because it was non-toxic and performed extremely well. When Freon, and other CFCs, were banned due to their harmful ...

### MANAGEMENT

**Program Executive:**  
Jason Crusan

**Program Manager:**  
Nancy Zeitlin

**Project Manager:**  
William Simmonds

**Principal Investigator:**  
Jacqueline Quinn

## DETAILED DESCRIPTION (CONT'D)

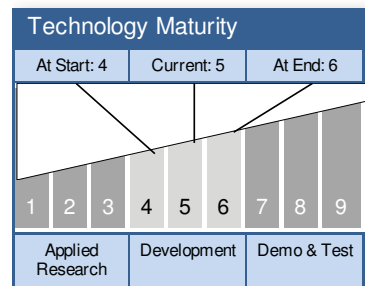
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environmental effects, new solvents were identified that were similar compounds but were not yet regulated. Eventually, these solvents also become regulated and unavailable for use. This project specifically did not consider halogenated solvents in order to find solvents or technologies that would not face future environmental regulations.



## TECHNOLOGY DETAILS

### Cleaning using ultrasonic agitation



### TECHNOLOGY DESCRIPTION

This technology uses conventional organic solvents with ultrasonic agitation to improve cleaning efficiencies.

This technology is categorized as a hardware subsystem for ground support or mission operations

- Technology Area
  - TA13 Ground & Launch Systems Processing (Primary)

### CAPABILITIES PROVIDED

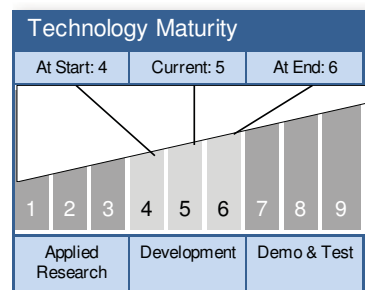
Ultrasonic agitation improves the cleaning efficiencies of conventional solvents for all contaminants. Hydrocarbon greases are fully cleaned, while fluorocarbon greases are still not completely removed from hardware.

This technology could be used to precision clean aerospace parts and ground support equipment.

Performance Metrics		
Metric	Unit	Quantity
Non Volatile Residue		

## TECHNOLOGY DETAILS

### Plasma cleaning



### TECHNOLOGY DESCRIPTION

Plasma technology is an extremely versatile technology which is useful in a variety of applications, such as:

- activation of materials prior to processing (gluing, soldering, etc...)
- etching or partial removal of surfaces
- coating of materials with different substances to impart different properties (hydrophobic/hydrophilic, lower friction, etc...)

Plasma technology also offers the capability to clean the surfaces of materials, allowing for the removal of any contamination which may be present while preserving the integrity of the materials itself. Plasma cleaning is a solvent-free cleaning method, making it particularly desirable.

This technology is categorized as a hardware subsystem for ground support or mission operations

- Technology Area
  - TA13 Ground & Launch Systems Processing (Additional)

### CAPABILITIES PROVIDED

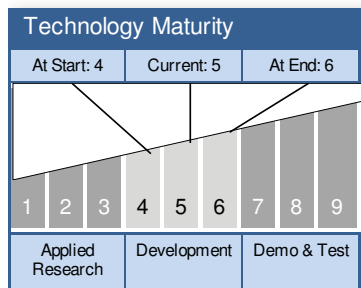
Plasma cleaning has shown promise on multiple contaminants. Evaluation of the technology is ongoing.

This technology could be used to precision clean aerospace parts and ground support equipment.

Performance Metrics		
Metric	Unit	Quantity
Non Volatile Residue		

## TECHNOLOGY DETAILS

### Super Critical Carbon Dioxide Cleaning



### TECHNOLOGY DESCRIPTION

Super critical carbon dioxide (SCCO<sub>2</sub>) is a fluid that can be used as a solvent. It is a preferred technology because it is nonflammable, non-toxic and has tunable solvent properties. SCCO<sub>2</sub> has found applications in many areas, such as natural products extraction or dry-cleaning, where there has been a desire to replace environmentally hazardous solvents.

This technology is categorized as a hardware subsystem for ground support or mission operations

- Technology Area

- TA13 Ground & Launch Systems Processing (Primary)

### CAPABILITIES PROVIDED

Hydrocarbon greases are fully cleaned, while fluorocarbon greases are still not completely removed from hardware.

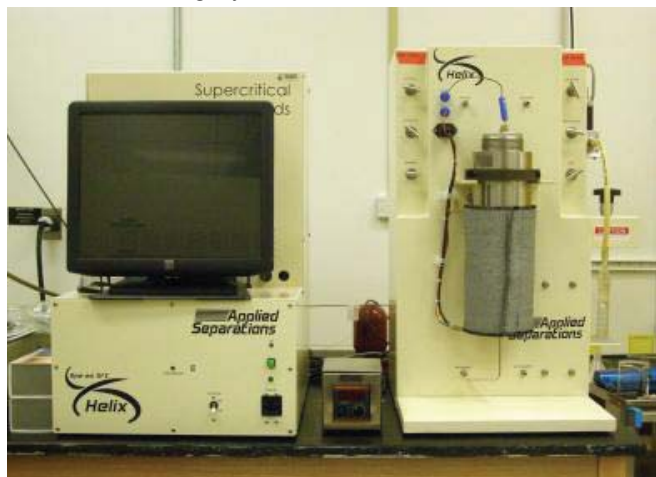
This technology could be used to precision clean aerospace parts and ground support equipment.



## IMAGE GALLERY



Plasma Cleaning System



## ABSTRACT (CONTINUED FROM PAGE 1)

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Thus, this project seeks to identify alternative precision cleaning solvents and technologies, including use of less harmful cleaning solvents, ultrasonic and megasonic agitation, low-pressure plasma cleaning techniques, and supercritical carbon dioxide extraction.







## ANTICIPATED BENEFITS

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### **To NASA unfunded & planned missions: (CONT'D)**

regulations.

### **To other government agencies:**

This technology benefits other government agencies that require precision cleaning technologies.

### **To the commercial space industry:**

The commercial space industry requires precision cleaning, and can benefit from this technology.

### **To the nation:**

Environmentally friendly and sustainable processes reduce long term costs and environmental impacts.